The Montana Wheat and Barley Committee has sponsored portions of the research and is providing this information for producers:

WHEAT STEM SAWFLY BIOLOGY AND RECENT RESEARCH TOWARDS MANAGEMENT

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The wheat stem sawfly is the major pest of wheat grown in Montana and is a key pest throughout the northern Great Plains. Annual losses in the area impacted by the wheat stem sawfly are estimated to be at least several hundred million dollars. This insect can develop in most cereal crops, plus cultivated and wild grasses. Losses are typically less apparent in barley and oat is invulnerable. Recent evidence suggests that the wheat stem sawfly is probably native, although it has been suggested that it is a recently introduced species.

All of the immature stages are found within the stem of the host plant. The distinctive adults are short-lived, with males emerging first and females a day or two later, typically in early summer in Montana. A female can lay around 30 eggs in her lifespan of less than a week. However, the period of adult emergence and flight into the growing crop typically lasts at least a month. This makes attempts to control populations by killing adults very difficult. The developing larvae feed throughout the stem. As they grow larger the larvae bore through the nodes, which impairs nutrient flow and reduces head weight. As the crop ripens the larvae descend to the base of the stem and girdle the interior by chewing a notch. The stem lodges at this weakened point and the larva seals the cut stem with excreted material. The mature larva descends to the crown within the cut stem where it overwinters until spring warming. Metamorphosis occurs within the cut stem later in the spring, and adult emergence occurs after pupation lasting one or two weeks.

A number of species of parasitic wasps are reported to use the wheat stem sawfly as a host in grassland. However, only two closely related species, *Bracon cephi* (Gahan) and *Bracon lissogaster* Muesebeck are known to attack the wheat stem sawfly. Of these, *B. cephi* is more widespread throughout the wheat production area that is impacted. *B. lissogaster* is more abundant in north central Montana and grows rarer further to the north and east. Both species paralyze the larger sawfly larvae, which are killed as they are consumed by the developing parasitic wasp. Both *B. cephi* and *B. lissogaster* have two generations per year in Montana. Occasionally, more than one *B. lissogaster* can develop on a single sawfly larva, whereas only one *B. cephi* can develop from a paralyzed sawfly larva.

Research on wheat stem sawfly management has a long history, starting in Canada in the 1920s. Over eighty years, many researchers have attempted to find ways to control this pest. Strategies explored included a variety of tillage and residue management approaches, plant breeding, plus foliar and soil applied insecticides. Of these approaches, plant breeding has yielded the best management tools, which are solid stem varieties. Insecticides have not been shown to be effective. Practices such as various types of tillage or residue burning were inconsistent, or did not impact the next generation of sawflies adequately enough to justify the practice. Rotations using cereal hosts had little impact on subsequent sawfly numbers, unless non-host oats was included. Rotations to non-grass hosts influenced local sawfly abundance, but may have had limited long term impact on

numbers due to the widespread prevalence of sawfly in our dryland agriculture, and also due to complications associated with growing and marketing these alternative crops.

Wheat stem sawfly research has increased significantly on the Montana State University campus since the mid-1990s. Increased efforts have been made possible by sustained, higher levels of funding. The research undertaken has targeted a number of possible avenues leading to sawfly management. As these are explored, they lead to new ideas or to the combining of ideas that will continue to develop an integrated management program for wheat stem sawfly. A MontGuide is being written based on the findings listed below and should be completed by mid-winter. However, continuing research is essential to increase grower options for sawfly management.

Montana Wheat & Barley Committee

Here is a list of recent projects, findings, and accomplishments:

I.

1. Solid-stem winter wheat varieties that were released are now planted extensively
2. A very solid spring wheat variety ‘Choteau” was developed and is widely planted
3. Improved solid stem wheat varieties are being developed continuously
4. Molecular markers for the stem solidness trait that have been identified facilitate breeding
5. Solid stem wheat kills some sawfly larvae, mostly at hatch and near harvest
6. An artificial diet for screening toxic compounds from non-host cereals has been improved
7. Methodology for collecting potential toxic compounds has been developed
8. Studies are exploring host plant resistance known as ‘tolerance’ under varying conditions

II.

1. The wheat stem sawfly pheromone system has been identified
2. An experimental trap was developed to screen pheromone lures for adult sawflies
3. Trapping experiments show that a single compound is as effective as more complex blends
4. A provisional degree-day model for sawfly emergence and flight period has been developed

III.

1. Wheat plants with growing stems produce three attractants for adult females
2. The amount of these attractants varies significantly in both winter and spring wheat varieties
3. Preference for certain cultivars appears to be linked to the amount of the attractant produced
4. Crosses of varieties that vary in preference has identified molecular markers for preference
5. Egg-laying preference in field is consistent from large adjacent blocks through adjacent plants

IV.

1. Attractive varieties planted in trap borders can protect large areas of less attractive crop
2. These narrow trap strips have been proven effective using both winter and spring wheat
3. Hollow stem traps should be hayed to kill the immatures when the flight of sawfllies ends
4. Solid stem trap crops may be left until harvest, but cutting will probably worsen
5. Hayed winter wheat traps surrounding unattractive spring wheat appear most effective

V.

1. A key is now available for distinguishing the two species of parasitic wasps attacking sawflies
2. The parasitic wasps appear more prevalent in fields adjacent to untilled or lightly-tilled fallow
3. Most parasitic wasps that are going to overwinter are in the lower third of spring wheat stems
4. They appear to be more randomly distributed throughout winter wheat stems
5. Spring wheat is more likely to have two full generations of parasitic wasps
6. Parasitic wasps can be conserved by maximizing postharvest residue height
7. This can be accomplished by combining higher in solid stem or less infested crops
8. For more heavily infested crops, swathing as high as possible will be beneficial
9. Parasitic wasp abundance in hollow and solid stem wheat appears similar
10. Parasitic wasps can be mass-reared or mass-collected for redistribution
11. Redistribution has now been made to more than 50 sites across 15 counties

VI.

1. *Fusarium* species, including species less pathogenic to wheat, kill some sawfly larvae
2. Strains of fungal species that are known insect pathogens have been discovered
3. An insect predator feeding on larval sawflies has also been discovered
4. Grazing wheat stubble may have an impact on overwintering sawfly populations
5. Foreign exploration for natural enemies has been led by USDA-ARS in Sidney
6. USDA-ARS found a parasitic wasp from China that has been studied under MSU quarantine

VII.

1. Sawfly overwinter survival may now be greater due to increased below ground cutting by larvae
2. Immature sawflies completing development are more vulnerable to high spring temperatures
3. Reduced seeding depth may contribute to this, as does bare, unplanted fallow ground
4. Newly-developed insecticides, including seed treatments, are screened when requested
5. Cultivation practices such as tillage or burning have been evaluated using current technology
6. Agronomic comparisons of heavily infested solid and hollow stem varieties continues

Funds supporting this research were provided by competitive and earmarked State, Regional, and Federal sources, in addition to the Montana Ag Experiment Station. The projects described above involve a number of researchers, graduate students, skilled laboratory staff, and many undergraduate student laborers. Implementation of the research relies heavily on collaboration across research disciplines, plus critical support from Ag Research Centers, County Extension Personnel, and numerous wheat growers statewide.